angle of attack to sudden gusts. The plane is kept in the position until considerable speed is lost and the tail drops of its own accord due to lack of support. The weight of the plane and its lower speed then make it practically independent of further gusts.

It can be seen from the foregoing that a knowledge of the prevalence of gusty winds at landing areas is of vital necessity if safe landings are to be made. From a meteorological viewpoint, the occurrence of winds that will cause dangerous landing conditions can be forecast with considerable accuracy. While this is being done more and more as time goes on, there is still room for considerable improvement in the knowledge of local areas where landings are dangerous in gusty weather. Surveys of various terminal airports to determine the areas of maximum turbulence in various winds are becoming a necessity with the increase of passenger flying now occurring. A survey of this kind would give the meteorologist the knowledge necessary to advise the pilot in the air of the gusty condition prevalent and the best landing area on the airport. This advice would be especially helpful at night when landing passenger planes, and would constitute another safety factor to aviation in general.

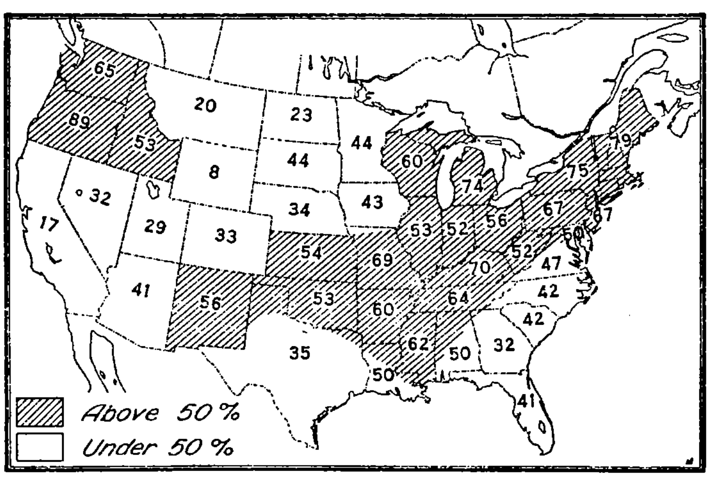
As an illustration of the value of being forewarned of the prevalence of such conditions, the following instance is cited. During January, 1929, a large area of low pressure passed over the middle Western States followed by a rather intense northwestern high. This pressure distribution caused extremely high, gusty surface winds along the Kansas City-Chicago Airway. Winds aloft were also extremely strong, reaching velocities of over 70 miles per hour. A mail pilot took off at Kansas City for the afternoon trip to Chicago, carrying one passenger. The pilot found when he was aloft that it was necessary to crab the plane into the northwest wind at an angle of over 45° in order to remain on the course. The air was so rough that at times they would drop 300 feet and then be driven upward the same amount, both actions being so violent that the wings vibrated alarmingly. The landing lights in the wings were shaken loose and hung in the air stream, banging against the wing with such force as to threaten to tear the tips off. After a 4-hour fight they arrived over Moline Airport, where red landing flares had been put out to advise them that a landing was dangerous. However, the ship was almost out of fuel and a landing had to be made. Wind velocties, as shown by the airport anemometer, were regularly over 40 miles per hour and during gusts reached as high as 58 miles per hour. Through the forethought of the field manager, an ambulance and fire truck had been summoned to take care of any contingencies that might arise in attempting to make a landing. The pilot circled the field and came into the wind, where he found that it was necessay to keep the engine almost wide open to make progress against it. He nosed the ship down and gradually lost altitude. When nearing the fence a sudden gust struck the ship, forcing one wing down until it was almost vertical, but it had sufficient air speed to overcome this and was quickly brought to normal. The pilot then actually flew the ship to the ground, where with its slow ground speed it stopped almost at once. He experienced great difficulty in taxying up to the shelter of a hangar, as with the least access of speed the ship wanted to take off again. However, his previous knowledge of the landing conditions prevailing, combined with his long experience, had enabled him to make a safe landing where none was thought possible.

RELATIONS BETWEEN WINTER TEMPERATURE AND PRECIPITATION

By THOMAS ARTHUR BLAIR

[Weather Bureau, Lincoln, Nebr., Jan. 2, 1931]

What is the relation between winter temperature and winter precipitation in the United States? The lowest temperatures of winter generally occur with fair weather near the center of an anticyclone. The heaviest winter precipitation usually falls with mild or moderate temperatures. May we assume, then, that as a rule warm winters are wet and cold winters dry. The following table and chart are an attempt to answer that question.



The data were taken from the tables of comparative State means printed in the annual summaries of climatological data by each section center. They are for the three winter months, December, January, and February, and only those years are counted in which the average temperature departure was $\pm 2°$ F, or more. Table I, in which the States are arranged by regions, gives for each State or section the number of times departures of temperature and precipitation were of like sign and of unlike sign and the percentage of the total having like signs. The percentages are entered by States on the chart, and areas where the percentage is greater than 50 are shaded.

In the shaded areas warm and wet winters are likely to occur together and cold and dry winters together. The presumption that the winters will occur in this way is strongest in Oregon, Michigan, New York, and New England. In these States three-fourths of the winters averaging 2° F. warmer or colder than normal have precipitation departures in the same sense. On the other hand, the chances are better than even that warm winters will be dry and cold winters wet in the South Atlantic States, Texas, the western upper Mississippi Valley, the Missouri Valley, the Rocky Mountain region from Colorado northward, the southern Plateau States, and California. They occur in this association nine times out of 10 in Wyoming, more than three times out of four in California, Montana, and North Dakota, and two times out of three in Nevada, Utah, Colorado, and Georgia.

The area of percentages above 50, which extends northeastward from New Mexico to the Great Lakes and New England, is obviously associated with the winter cyclones which appear in the southwest and move northeastward. Rain and warm weather occur in their path and snow and cold weather to the northwest. At Dubuque, Iowa, it was found [1] that precipitation in winter occurs more frequently with falling temperature than with rising. In the Plateau and Pacific States the well-known relation between precipitation and the latitudinal position of cyclones as they approach the coast is evident, especially in the marked contrast between Oregon and California. Northern LOWS are attended by warm and wet weather in Oregon and warm and dry in California; southern LOWS by cool and dry weather in Oregon and cool and wet in California. These statements are, of course, incomplete and partial and serve only to illustrate the relations suggested by the chart. It is beyond the scope of this note to enter into a discussion of the conditions under which winter precipitation occurs in the various States and sections of the country. The sole object has been to compile and present the facts of record, expressed in State averages, showing the relationship between winter temperature and precipitation departures.

TABLE 1.—*Number of times winter temperature and precipitation departures were of like and unlike signs. Only those winters were counted in which the average temperature departure for the three months, December, January, and February, was ±2° F. or more*

States	Departures of—		Percentage having like signs
	Like signs	Unlike signs	
North Atlantic:			
New England	15	4	79
New York	15	5	75
Pennsylvania	14	7	67
New Jersey	12	6	67
Maryland and Delaware	8	8	50
Sums	64	30	68
South Atlantic:			
Virginia	9	10	47
North Carolina	8	11	42
South Carolina	8	11	42
Georgia	7	15	32
Florida	7	10	41
Sums	39	57	41

[1] T. A. Blair, Local Forecast Studies—Winter Precipitation, M. W. R., 52: 79-85.

TABLE 1.—*Number of times winter temperature and precipitation departures were of like and unlike signs. Only those winters were counted in which the average temperature departure for the three months, December, January, and February, was ±2° F. or more*—Continued

States	Departures of—		Percentage having like signs
	Like signs	Unlike signs	
Lake region, Ohio Valley, and eastern Mississippi Valley:			
Michigan	14	5	74
West Virginia	11	10	52
Ohio	15	12	56
Indiana	13	12	52
Kentucky	14	6	70
Wisconsin	12	8	60
Illinois	19	17	53
Tennessee	16	9	64
Alabama	12	12	50
Mississippi	13	8	62
Sums	139	99	58
West Gulf:			
Louisiana	9	9	50
Texas	6	11	35
Sums	15	20	43
Central Plains and middle Mississippi Valley:			
Missouri	18	8	69
Kansas	13	11	54
Oklahoma	9	8	53
Arkansas	9	6	60
Sums	49	33	60
Western upper Mississippi Valley, Missouri Valley, and Rocky Mountain:			
Iowa	18	24	43
Minnesota	11	14	44
North Dakota	5	17	23
South Dakota	11	14	44
Nebraksa	12	23	34
New Mexico	10	8	56
Colorado	6	12	33
Wyoming	1	11	8
Montana	4	16	20
Idaho	9	8	53
Sums	87	147	37
South Plateau and south Pacific:			
Nevada	6	13	32
Utah	5	12	29
Arizona	7	10	41
California	1	5	17
Sums	19	40	32
North Pacific:			
Oregon	17	2	89
Washington	13	7	65
Sums	30	9	77

INTERPOLATION OF RAINFALL DATA BY THE METHOD OF CORRELATION

ERIC R. MILLER

[Weather Bureau, Madison, Wis.]

The object of this paper is to apply to a climatological problem a method already well established in other sciences. Suppose that it is wished to interpolate from observations at near-by stations the monthly rainfall at a station where observations have been taken previously. I shall use the symbol Y to refer to rainfalls at the first, X, at the others, y and x to refer to deviations from the mean rainfalls.

Think of a "scatter diagram" each point of which represents the simultaneous rainfalls, X measured on a horizontal scale, Y on a vertical scale. The "regression line" of the statistician (**6**, p. 120) has the property that the sum of the squares of the distances of the dots of the scatter diagram measured parallel to the Y axis from the regression line, is less than from any other line. Hence, under a least-squares criterion of approximation, the regression line is the "best" representation of the relation between Y and X for all amounts of rain. The following remarks will be restricted to straight regression lines, but the fitting of curved regression lines is also practiced.

The formation of the regression equation, representing algebraically the regression line, involves calculation of the standard deviations of the observed X's and Y's, and their coefficient of correlation. Concise examples of this are given in books on statistics (**8**, p. 178–179), (**6**, p. 123) and the calculation is easily carried out with the aid of Crelle's Tables (**1**).

Horton (**3**) has given some correlation coefficients calculating from 12 months taken at random. In order to ascertain the effect of change of season upon the correlation coefficient, I have calculated it for the 32 years (1897–1928) rainfall at Waupaca and Pine River, Wis. (14 miles apart), for January, when practically all rain falls in "general" storms for May, the wettest month, with many heavy thunderstorms, and for August, a month characterized by very local rain and drought.